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THE METHODS OF CONDUCTING STUDIES WITH THE APPLICATION OF COMBINED DIDACTIC INTERACTIVE PROGRAMME SYSTEMS

Maxim Polskiy

Abstract: *The methods of the application of the Combined didactic interactive programme system on electrical engineering disciplines has been worked out and the possibility of its application for providing a complex of different kinds of studies: lectures, tutorials, laboratory studies and also for organizing students' independent work has been verified. The given methods provide the organization of the reproductive (recognition and reproduction) and productive heuristic educational-cognitive students' activity in conditions of gradualness and completeness of education with the closed directed automatic control.*

Keywords: *lecture, tutorial, independent students' work, combined didactic interactive programme system, reproductive and productive educational-cognitive activity.*

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Introduction

The problem of the rational use of information technologies in the educational process is the most important in pedagogics nowadays. The complex use of such means for methodical provision of different kinds of studies in the widest aspect is proved by I.V. Roberts' [Роберт, 1994], studies, and for the field of general technical disciplines – by the works of S.V. Panyukova [Панюкова, 1998] and L.H. Zainutdinova [Зайнутдинова, 1999].

The Combined didactic interactive programme system (CDIPS) being used for conducting lectures, tutorials, laboratory studies and students' independent work (SIW) is developed at the Electrical engineering chair of Astrakhan State technical university. CDIPS provides the closed directed automatic control both for the reproductive and productive heuristic educational-cognitive students' activity.

Let us examine the methods of the application of this system on electrical engineering disciplines for organizing and conducting different kinds of activities

Lectures

According to the traditional training technology in an institution of higher education lectures are considered to be the main and the most important kind of studies and lecturing is committed to the most erudite and experienced teachers. The lecture contains a great volume of a new teaching material given to students. However a teacher with such kind of studies "uses the unfastened control in the scattered information process" [Беспалько, 2002, с. 181]. As a result of it the lecture can not pretend to providing a high-quality learning of the educational-cognitive activity by students.

Meanwhile according to V.P. Bepalko this form of training is suitable for creating the initial orientation in the studied discipline. Learning the educational-cognitive activity in such cases is corresponding to the first level (recognition). Therefore, a traditional lecture must be used by teachers at the initial stages of training.

Nowadays many institutes of higher education have specially equipped lecture halls, giving the opportunity of modern computer support of this kind of studies. In the works [Казаков и др., 1995; Задорожный, 1997; Зайнутдинова, 1999] the experience of organizing lectures in the room equipped with a multimedia-projector is viewed. The activation of students' attention at the expense of showing colourful, visual and moving pictures on the screen is stressed.

Astrakhan State technical university (ASTU) has also special lecture-halls equipped with multimedia projectors, where lectures are held. Many teachers prepare interactive presentations more often designed with the help of PowerPoint application. Created within the limits of the present research the CDIPS on electrical engineering disciplines are applied by us at the lectures in the lecture-halls equipped with multimedia projectors.

Conducting lectures with the help of the CDIPS intensifies the role of the didactic education visualness principle. At the same time besides the illustrative function, computer graphics, guaranteeing the recognizability of the represented objects we also took into consideration its cognitive functions, enabling to use one of the most important cognitive mechanisms of man's thought – the ability to think by means of complicated spatial images. This approach has a vital importance for electrical engineering disciplines as we speak about expounding abstract teaching material of a high complexity level.

Our experience shows the following advantages of CDIPS during lecturing:

- the extension of teaching information capacity;
- the enlargement of using visual means;
- the possibility of the virtual laboratory experiments demonstration.

Let us emphasize again that the lecture does not guarantee students a high level of learning educational-cognitive activity. In connection with this we view these studies as a means of initial orientation organization during learning one or another topic of the disciplines of electrical engineering cycle. Within the limits of lectures CDIPS is used by us at the initial stages of training.

Tutorials

During tutorials there is a considerable increasing of activity of educational-cognitive students' activity. Let us examine the methods of conducting tutorials with the use of CDIPS shown in figure 1.

Tutorials are conducted in the university display rooms. At the same time it is necessary for every student to work at a computer individually. As a rule it is reached at the expense of conducting studies in subgroups (12-15 people).

Let us examine the methods of conducting tutorials by the example of the CDIPS "Quadripoles". The contents include the following topics:

1. The quadripole definition.
2. The quadripole equations.
3. The experimental definition of A-parametres.
4. Quadripole equivalent schemes.
5. Quadripole combinations.
6. Quadripole transfer function.

After triggering CDIPS "Quadripoles" the title-page on which one can see two buttons "topic choice" and "the information about the programme" appears on the screen. After pressing the button "topic choice" a student gets an opportunity to pass on to one or another topic of the studied section "Quadripoles".

According to the offered methods of conducting a lesson (fig.1) a teacher offers the students to review the theoretical material studied at the lecture, e.g. the topic "The quadripole equations". For several minutes the students briefly look through the contents of this topic (the main notions, methods and formulae, needed for task solving).

Having reviewed the necessary theoretical material, the students pass on to fulfilling a practical task, corresponding to the first level of learning the educational-cognitive activity (recognition). The first level questions and tasks are the simplest. They can be regarded as an addition to reviewing theoretical

material. The main purpose of the first level tasks is the recognition of the teaching material previously studied at the lecture by the students.

Every student is given an individual task consisting of 6 questions selected at random. Every question has several variants of answer, among which the only one is true. The interactive training dialogue script assumes an unambiguous reaction to every student's answer: the confirmation of the right action or giving out a tip in case of an error. However to get the lowest passing score ($\text{mark} \geq 4$) for the admission to the second level tasks is possible only if you answer all the questions properly mainly from the first effort and without any tips. Let us remind that according to [Беспалько, 2002] the estimation of learning educational-cognitive activity must be realized with the help of learning coefficient CI , evaluated by the ratio of the number of the essential operations properly done by the students "p" (the actions being done by the doer and leading to the achievement of activity purpose) to the total number of the essential operations "m" in the task: $CI = p/m$. Here the condition of the completeness of training at one or another level conforms with the value $CI \geq 0,7$. Within the limits of CDIPS the mark is given out according to five ball scale. It is connected with the fact that most students understand this very approach. Here the 4 ball mark conforms with the value of learning coefficient $CI \approx 0,7$. After the completion of doing the task the student is given a mark taking into account the total number of questions, the number of the right answers and the number of efforts to answer the same question. If the student gets a mark less than 4 balls ($CI \leq 0,7$), then the teacher recommends him to review the theoretical material again and then to do this task once more time. In case when the mark is 4 balls and higher ($CI \geq 0,7$), then the student passes on to doing the second complexity level practical task.

The form of the practical tasks organization viewed above and namely the choice of one of the answer variants yields in its pedagogical effectiveness to the traditional form of the teaching tasks organization in the course of electrical engineering disciplines. So, e.g. in the well-known electrical engineering tasks collections [Бессонов, 2000] or [Шебес, Каблукова, 1990] we find a great number of tasks worked out at a high methodical level, the solution of which assumes using these or those laws, methods or techniques and is accompanied by a considerable range of calculations. Most of these tasks from the work's [Беспалько, 2002], point of view can be divided into two groups:

- standard tasks, the conditions of which allow direct application of the learnt algorithms, rules or formulae for their solving;
- non-standard tasks, requiring from the student to use the earlier learnt knowledge in non-standard situations. Here the student transforms the initial conditions of the task in order to bring them to standard solution methods. Such an educational-cognitive activity is called heuristic.

At the tutorials within the limits of the CDIPS standard and non-standard tasks are provided by us. At that standard tasks are referred to the second complexity level in view of their corresponding to the second level of learning the educational-positive activity (algorithmic activity). According to the methods of conducting a tutorial (fig.1) the student may begin doing standard tasks after getting the lowest passing score at the first level.

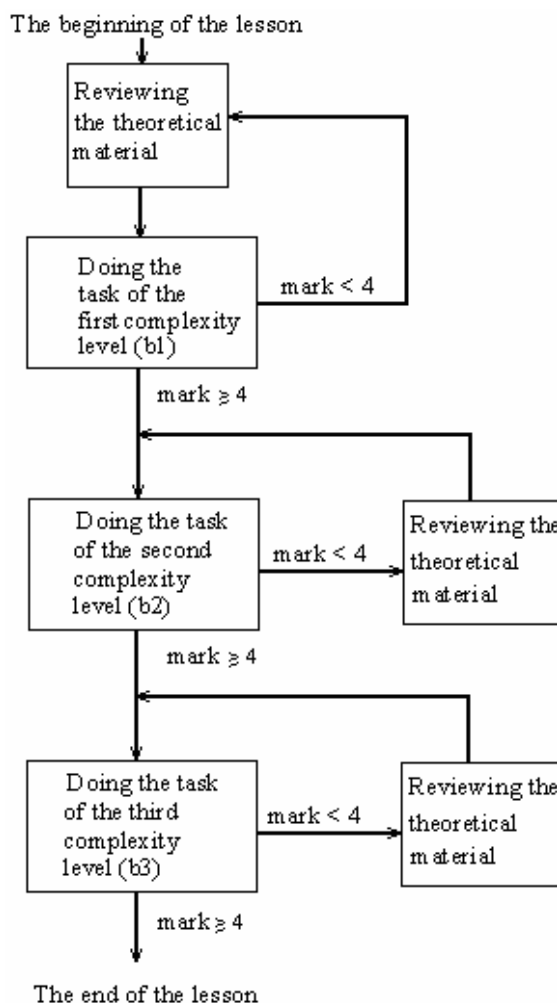


Figure. The methods of conducting a tutorial with the use of the combined didactic interactive programme system on electrical engineering disciplines

The programme gives out every student an individual task (e.g., "Quadripole equivalent schemes"). The variance of the second level tasks is provided by the casual choice of electrical circuits and their parameters.

While the student is doing the second level complexity task the interactive educational dialogue is accompanied by the functional inspection of all the student's actions. CDIPS controls every step of training and efficiently forms the specific corrective teaching effects (declarative feedback).

For securing his object the student follows the strictly established algorithm designed in the programme. Any opportunity of choosing any other way of solution is excluded. Thus thanks to the strictly established limits of the educational-cognitive activity the student learns the main algorithms and ways of solving standard tasks of electrical engineering disciplines.

After finishing the calculated task of the second complexity level with the mark less than 4 balls the student should review the theoretical material again and then do the task of this level one more time. In case of successful finishing this task (the mark is 4 balls and higher) the student may pass on to solving non-standard tasks.

Non-standard tasks are referred to the third level complexity tasks as they correspond to the third level of learning the educational-cognitive activity (heuristic activity).

The practical tasks of the heuristic level are provided in the CDIPS "Quadripoles" for the topic "Quadripole transfer function". Here the student is given an opportunity of the independent choice of the electric circuit scheme for studying and optional specifying its parameters. The student may also choose the way of solving convenient for him. CDIPS doesn't restrict the freedom of actions. The interactive training dialogue is accompanied by the more enlarged stage-by-stage control over the student's actions.

The student inputs the intermediate results got by him during the task fulfillment into the special fields of the CDIPS where they are checked up. On basis of the intermediate results input by the student (if these results go into the admissible intervals) the graph of the frequency characteristics of the studied electrical circuit is being made in an automatic regime on the screen. In case of making errors one can see the departure of the received results from the reference valuations in the graph and correct his activity. Thus the student is given an opportunity to make conclusions about the appropriateness of the solving process individually by means of visualizing the discrepancy of the results input by him and reference valuations on the screen. In a certain sense the programme shows the student "in the implicit form" his possible mistakes (visual-suggestive feedback).

At the final stage the sample graph appears on the screen, the programme evaluates the departure of the results input by the student from the sample and gives him a final mark.

After the successful fulfilment of the third complexity level task by the students (the mark is 4 balls and higher) the training process within the limits of this topic can be found complete. Otherwise (the mark is less than 4 balls) the student is recommended to review the theoretical material once again and then to do the tasks of this level one more time.

Thus it is shown that the methods of conducting a tutorial (the scheme of which is shown in fig.1) with the use of the CDIPS on electrical engineering disciplines is worked out taking into account the conditions of graduality and completeness of training. The graduality means that no level of learning can be missed in course of training. In the process of task solving the student gradually pass from simple tasks to more difficult ones. The completeness means that at every level of learning educational-cognitive activity the mark must be not less than 4 balls.

It must be noted that the teacher's role in organizing tutorials with the use of the CDIPS on electrical engineering disciplines is:

- to explain the volume and the contents of the studied topic, to pay attention to the notes, definitions, formulae and methods from the theory which can be useful in the process of task solving at the beginning of the lesson;
- to control the fulfilment of the conditions of gradualness and completeness of training during the lesson. The educational-cognitive students' activity at the tutorial must take place according to the methods shown in fig.1;
- to give professional advise on the questions connected with the rules of the work with the programme during the lesson. The student's attention must be concentrated mainly on the studied topic.

On the whole the teacher's activity with using the CDIPS during the tutorials on electrical engineering disciplines becomes considerably easier. He does not have to form individual training tasks as they are automatically generated by the CDIPS. The teacher does not have to check up the students' solutions. However the quality of checking made by the CDIPS appears to be much higher. No teacher can physically provide such degree of inspection, especially the check-up of numeric values.

Thus, the application of the CDIPS at tutorials provides:

- the opportunity of reviewing the theoretical material;
- giving out individual variants of the training tasks which are characterized by a high variance to the students during the lesson;
- students' fulfillment of practical tasks corresponding to the first, second and third levels of learning the educational-cognitive activity during the lesson in conditions of gradualness and completeness of training with the closed directed automatic control;
- the evaluation of the results of doing the training task;
- easing the teacher's role in controlling the training process;
- the colourfulness and visualness of presenting the teaching information on the screen.

Laboratory studies

The physical experiment is an essential part of the training process in teaching electrical engineering disciplines. When using a traditional technology of conducting laboratory studies the tasks are fulfilled on various laboratory stands and experimental installations, adjusted to the certain, narrow enough ranges of changing the controlled values.

The use of software and computers as "virtual laboratories" considerably extends the experiment abilities in comparison with the physical simulation and also sets free from considerable explicit costs for producing special models.

Nowadays lessons in many institutes of higher education are conducted with the use of electronic computers and special program packages such as Microcap, System View, Electronics Workbench and others.

The Electronics Workbench system is the most popular programme for modelling electrical circuits. It favourably differs from all the others by the simplicity of programming, the availability of usual measuring instruments models and a wide set of elements. Such a "virtual laboratory" allows realizing a natural sequence of making an experiment.

The electrical engineering chair of ASTU has a considerable experience in conducting laboratory studies and also term papers with the use of EWB on electrical engineering disciplines. The special methodical textbooks for conducting laboratory studies and term papers with the use of EWB on the discipline "Circuit theory principles" are published. The lack of feedback and accordingly the impossibility to realize the closed directed automatic control over the educational-cognitive students' activity should be referred to the disadvantages of the "virtual laboratory" on basis of Electronics Workbench.

The CDIPS offered in this research allows realizing feedback when making a virtual experiment and provides control.

The experience of conducting laboratory works within the limits of the CDIPS with using a virtual laboratory Electronics Workbench 5.12 allows emphasizing the following advantages in comparison with the traditional methods:

- providing the automatic closed directed control over the educational-cognitive students' activity;
- decreasing time spent by the students on doing all the tasks of laboratory work, which allows to pass a test in this work within one lesson;
- the opportunity for every pupil to conduct laboratory works individually, which assists in better understanding of the studied questions;
- easing the teacher's activity on managing the learning process during a laboratory lesson.

In spite of the advantages enumerated above it should be noted that computer simulation can not in full measure change real physical experiments. Because of this very reason we combine the studies in real laboratories with attracting the "virtual laboratory" on basis of Electronics Workbench in approximately equal ratio.

Independent work

The new national educational standards on electrical engineering disciplines are characterized by decreasing the number of the office hours and increasing the requirements to students. This contradiction is compensated by giving considerable range of hours to the student's independent work (SIW). Because of this one of the main teacher's tasks is an effective organization of students' selftraining.

The electrical engineering chair of ASTU has a considerable experience of applying the didactic interactive programme systems in organizing students' selftraining. For the last 15 years the training-apparatus programmes, electronic and test systems have been applied in organizing SIW.

Since 2004 the CDIPS have been applied in organizing students' selftraining at the electrical engineering chair of ASTU. This means most of all meets the tasks of SIW: provides the familiarization with the theoretical material, practical tasks (of the first, second and third levels of learning the educational-cognitive activity), the functional and stage-by-stage inspection of the student's actions.

The main advantage of the CDIPS during the student's independent work with it is the organization of the interactive training dialogue. Doing some actions, solving some tasks a student gets the teaching system's reaction which evaluates the quality of his actions and gives out the corrective influences in case of making errors. In other words the CDIPS takes upon itself a part of teacher's management functions.

It must be noted that a student has no time limits and may work with the programme with the individual speed convenient for him. Moreover the choice of one or another complexity level can be made by the students independently. Such approach allows the student to make the self-appraisal of his knowledge level.

For organizing SIW with the use of the CDIPS the hours in the time-table of interchair use display rooms are reserved. Moreover many students do their independent work at home. From our point of view the use of the CDIPS within the open education is a perspective direction.

Conclusion

The Combined didactic interactive programme system worked out by the author is applied at the electrical engineering chair of Astrakhan State technical university for providing a complex of different kinds of studies: lectures, tutorials, laboratory studies and also for organizing students' independent work. The methods of applying CDIPS, providing the organization of the reproductive (recognition and reproduction) and productive heuristic educational-cognitive students' activity in conditions of gradualness and completeness of education with the closed directed automatic control.

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